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Calcium and Phosphorus—Dietary Concerns //

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In recent years, attention has been focused on the question of optimal levels of calcium and phosphorus for man. Dietary surveys continue to show that many persons fail to obtain recommended amounts of calcium. Concern has been expressed that dietary levels of phosphorus may be high enough to result in undesirable calcium-to-phosphorus ratios which may lead to certain adverse effects on body metabolism.

This issue of Nutrition Program News will report some of the current facts and thinkings about calcium, phosphorus, and calcium-to-phosphorus ratios and about the importance, utilization, recommended allowances, food intakes, and food sources of these two minerals.

IMPORTANCE OF CALCIUM AND PHOSPHORUS

Calcium and phosphorus are largely responsible for the hardness of bones and teeth. About 99 percent of body calcium and 80 percent of body phosphorus are found in these two tissues.

Calcium in other body tissues and fluids helps in the proper functioning of the heart, muscles, and nerves, and helps blood to coagulate during bleeding. These functions of calcium are so important that, if necessary, calcium will be removed from bones in order to maintain a precise level in the blood and other body tissues.

Phosphorus, an essential part of every body cell, plays an important role in the release of energy from foods and functions in other chemical reactions within the body.

CALCIUM-TO-PHOSPHORUS RATIO

Significance

A calcium-to-phosphorus ratio is simply a way to relate amounts of these minerals to each other. An undesirable ratio is one in which there is too little calcium in relation to

the phosphorus in the diet. This imbalance between these two minerals may contribute to an imbalance in the body calcium, with the result that more calcium is lost from the body than is absorbed from food. As a result, calcium, which is needed for use in many vital body functions, may be withdrawn from the bones.

Little is known about the effects of an undesirable ratio on bone development in children. Some research has suggested that for adults, an undesirable ratio may be a contributing factor in the development of osteoporosis. This disease is characterized by a loss in total skeletal bone mass. During growth, and even in adult life, new bone continues to be formed and old bone is resorbed. In osteoporosis, calcium that has been removed from bone is not replaced. Jawbone loss may be a forerunner of osteoporosis. The response of skeletal bones to inadequate dietary calcium varies, and jawbone is thought to be the first affected.

Dietary Ratios

Information on calcium-to-phosphorus ratios of diets is limited. The intake of phosphorus is almost always equal to or exceeds the intake of calcium, which would indicate a ratio less than 1:1. In the dietary ratios obtained from various studies presented in this section, calcium has been given a value of 1 with the value for phosphorus being less, the same, or more than 1 depending on the quantities of the two minerals compared.

In a study by Murphy and coworkers (1970) on the nutrient content of Type A school lunches from 300 schools, the average calcium-to-phosphorus ratio was 1:1.1. White (1969) analyzed composites of a day's self-selected diets of girls and young women and found an average content of 780 mg of calcium and 993 mg of phosphorus, or a ratio of 1:1.3. Tipton and Stewart (1970) analyzed self-chosen diets of three adult men. The average content of calcium was 1,580 mg and of phosphorus 2,200 mg or a ratio of 1:1.4. A mean calcium-to-phosphorus ratio of 1:1.4

was also reported on analysis of a week's meals from 50 colleges.

Recommended Ratio

The Food and Nutrition Board (FNB) of the National Research Council recommends a calcium-to-phosphorus ratio of 1:1 for all age groups except for infants. The recommended ratio in early infancy is 1.5:1.

Calcium is found in larger amounts in bone than is phosphorus, the ratio being approximately 2:1. This would seem to suggest that the ideal dietary ratio should be 2:1, particularly during growth. However, phosphorus is found in larger amounts than calcium in the soft body tissues such as muscle. Also, the phosphorus content of ordinary diets almost always is equal to or exceeds the calcium content.

UTILIZATION OF CALCIUM AND PHOSPHORUS

The amounts of calcium and phosphorus needed to perform vital body functions vary from person to person and under different conditions. Of the calcium ingested in a varied diet approximately 20 to 30 percent is utilized. There is little agreement among researchers as to the amount of phosphorus utilized. Estimates range from as low as 10 percent to as high as 70 percent. Some of the factors that affect the body's use of calcium and phosphorus and, consequently, the amounts needed, follow.

Dietary Calcium-to-Phosphorus Ratio

Although calcium and phosphorus absorption is believed to be associated, the relationship is not clearly defined. Usually the recommended dietary ratio is between 2:1 and 1:2 for optimal calcium absorption. However, ratios outside these limits have been found to be satisfactory if vitamin D intake is adequate, but limits outside of these ratios have not been defined.

Vitamin D

An active form of vitamin D enhances the absorption of calcium by inducing the formation of a cellular calcium transport system. A vitamin D dependent calcium-binding protein may function as a part of this system for transporting calcium across the intestinal wall. Little calcium can be absorbed when vitamin D is absent. Vitamin D also helps to maintain adequate body phosphorus levels by enhancing its absorption and, more importantly, by helping to control its excretion from the body by way of the kidney. In addition, vitamin D functions in the release of calcium and phosphorus from bone when the amount of calcium drops below a certain level in the blood.

Body Need

Dietary calcium and phosphorus are utilized more efficiently in periods of growth, when relatively greater amounts are needed to increase the volume of bone and to strengthen bone already formed. In contrast, adult needs for calcium and phosphorus for use in bones are only to maintain bone that has already been formed. Pregnant and nursing women need greater quantities to meet the needs of the growing fetus and for milk production.

Level of Intake

A greater proportion of dietary calcium is absorbed when intake is low. As the level of dietary calcium increases, the percentage absorbed decreases. However, a larger quantity of calcium is absorbed on a high intake.

Protein

A direct correlation has been demonstrated between dietary protein intake and urinary calcium excretion. Studies show that as dietary protein increases, urinary calcium excretion increases. However, the net effect of dietary protein on calcium retention and absorption is not as well known, particularly during growth periods.

The effect that a high protein intake may have on the development of osteoporosis has been speculated. Short-term metabolic studies of diets providing 95 g of protein and 500 mg of calcium—probably not an uncommon situation in the United States—have produced a net loss of calcium from the body of 58 mg per day. This would amount to approximately a 10-percent loss of total body calcium over a 10-year period. In contrast, epidemiological studies of skeletal status of populations show no skeletal loss in individuals under age 40. The relationship between protein intake and calcium retention requires further investigation and clarification.

Oxalic Acid and Phytic Acid

Both oxalic acid and phytic acid form insoluble calcium and phosphorus salts in the intestine, which inhibit the absorption by the body of these minerals. Oxalic acid is found in beet greens, chard, rhubarb, and spinach. Phytic acid is found mainly in the outer coats or bran of cereals and in legumes.

The enzyme phytase, found in many cereals, destroys phytic acid during the leavening of bread containing whole-meal flour. Hence, greater amounts of phytic acid are found in the unleavened bread.

The amounts of these two acids in typical diets are not of practical importance, if ample amounts of calcium and phosphorus are provided. Thus, foods that contain these acids should not be eliminated from the diet because of their possible effect on calcium and phosphorus as they are

good sources of other nutrients. However, the inclusion of large amounts of whole grains and unleavened products made from whole-grain flour, such as might be found in the diets of proponents of high-fiber or “natural” foods, may supply enough phytic acid to cause some concern, especially if total calcium intake is low.

DIETARY ALLOWANCES

Calcium

Opinions differ as to the amount of calcium the diet should provide. Some groups suggest substantially larger amounts than others. The main factor in this controversy is that most persons can remain in calcium equilibrium (calcium intake=calcium output) on a wide range of intakes. In general, if a person regularly consumes large amounts of calcium, the body will adjust by absorbing proportionately less and excreting more calcium. A reverse but similar type of adaptation occurs on a low calcium diet—that is, calcium is more efficiently absorbed and its excretion from the body is decreased. This adaptive capacity makes it difficult to determine minimal calcium needs.

Proponents of a low calcium allowance maintain that much of the world’s population exists on such an intake without adverse effects. The Food and Agriculture Organization-World Health Organization (FAO-WHO) has proposed a practical allowance of 400 to 500 mg per day for adults. The FAO-WHO considers that these levels would adequately meet the needs of the majority of adults in the world’s population, particularly in countries where calcium-rich foods are not available or are available in limited quantity, and where protein intakes tend to be lower.

The Food and Nutrition Board (FNB) of the National Research Council has taken the position of recommending a more generous allowance. For adults, 800 mg per day is recommended, which is about twice the amount advised by the FAO-WHO. The reason for the FNB’s higher recommendations is based on three observations: (1) Not all persons are able to adapt to marginal calcium intakes, (2) larger amounts of calcium-rich foods are more readily available in the U.S. food supply and are customarily consumed by many individuals, and (3) protein intake is relatively high in this country.

Children need two to four times as much calcium as adults per unit of weight. The allowances established by the FNB for children 1 to 10 years have been set at 800 mg per day. During the preadolescent and puberty stages (10 to 18 years), a higher intake—1,200 mg—is recommended to provide for the rapid growth that characterizes this period. Allowances at all ages are the same for males and for females, although females generally have a smaller skeletal structure and usually weigh less than males. Females need adequate stores of calcium to help meet increased needs associated with pregnancy and lactation.

Phosphorus

In 1968 the FNB recommended dietary allowances for phosphorus for the first time. Less research has been done on the utilization and requirements of phosphorus than of calcium. Thus, without much evidence available other than ratios of calcium and phosphorus found in different parts of the body, allowances for phosphorus were made equal to those for calcium for all age groups except for the infant. In the 1974 revision of the Recommended Dietary Allowances (RDA), the phosphorus allowance for children 1 to 10 years is 800 mg per day; for preadolescents and adolescents 1,200 mg per day; and for adults 800 mg per day.

CALCIUM AND PHOSPHORUS CONTENT OF THE AMERICAN DIET

Many persons fail to choose diets that meet the RDA for calcium. Data from the USDA’s Household Food Consumption Survey, 1965-66, and from DHEW’s Ten-State Nutrition Survey, 1968-70, and the Preliminary Findings of the Health and Nutrition Examination Survey (HANES), 1971-72, indicated that, for most age categories, females were less likely to meet the standards for calcium than males. Mean calcium intakes tended to increase with age for male adolescents and to decrease with age for female adolescents. Calcium intakes of pregnant and lactating women tended to be less than the recommended allowances as well. Males over 75 years consumed diets that were 20 percent or more below calcium recommendations. Generally, there was evidence of lower calcium intakes associated with low income levels.

Little information is available on the phosphorus content of diets. Phosphorus is found in nearly all foods and there is no evidence of a dietary deficiency in man. The phosphorus content of a typical American diet is higher than the calcium content. The average daily phosphorus intake of adults in the United States has been estimated at 1.5 g.

FOOD SOURCES

Calcium

Milk and milk products.—Milk and milk products, such as cheese, ice cream, and yogurt, are the major sources of calcium in diets in the United States. These foods contribute about 75 percent of the total food supply of calcium.

The following amounts of milk are recommended daily:

8-ounce cup fluid milk

Children under 9	2 to 3
Children 9-12	3 or more
Teenagers	4 or more
Adults	2 or more
Pregnant women	3 or more
Nursing women	4 or more

Although recommendations are given in terms of amounts of milk to be consumed daily, other foods can count towards the milk consumption goal. Common portions of cheese and ice cream and their milk equivalents in calcium are:

1-inch cube Cheddar-type cheese	= 1/2 cup milk
1/2 cup cottage cheese, ice cream, or ice milk	= 1/3 cup milk
2 tablespoons cream cheese	= 1 tablespoon milk
1 cup plain yogurt	= 1 cup milk

Milk used in other prepared foods such as cream soups, sauces, and puddings can also be counted.

Intolerance to milk.—Certain persons are unable to tolerate milk because of a lactase deficiency. Lactase is an enzyme that digests lactose, a form of sugar found in milk. Depending upon the severity of the lactase deficiency, undigested lactose produces various symptoms such as abdominal distension, cramps, or watery diarrhea. Infants and children who have the rare congenital lactase deficiency are usually unable to tolerate the level of lactose consumed in a typical serving of milk at one feeding.

Some persons who do not show a milk intolerance in childhood develop a milder form in the adult years. Although a normal serving of milk, usually one cup, is well tolerated by individuals with partial lactase deficiency, larger amounts often produce discomfort. The incidence of adult-onset lactase deficiency varies according to racial origin and geographic location. This deficiency is high (60 to 90 percent) in persons of Mediterranean, African, and Asiatic extraction and low (2 to 8 percent) in those of Scandinavian and West European ancestry. The incidence of partial lactase deficiency (or lactase insufficiency) in children of different ethnic origins is not known at this time.

Both the Protein Advisory Group of the United Nations and the FNB have stated that to discourage programs that promote the use of milk out of a fear of its intolerance is not advisable at this time. The consumption of moderate amounts of milk is nutritionally beneficial and, for most persons, produces no obvious adverse effects. For those persons with a milder lactase deficiency, fermented milk products such as cheese and yogurt—in which some of the lactose has been broken down—can often be included without producing any adverse effects. However, milk should not be included in diets of children who have the rare congenital type of total lactase deficiency.

When milk cannot be taken, calcium salts are sometimes given to supplement the dietary intake. Although calcium salts are well utilized, it must be remembered that their substitution for milk as a calcium source may limit other

essential nutrients in the diet derived from milk, such as riboflavin and protein.

Other sources of calcium.—In general, foods other than milk and milk products provide only limited amounts of calcium in an average diet. Vegetables which are worthwhile sources of calcium are: Certain dark-green leafy vegetables—such as collards, dandelion greens, kale, mustard greens, and turnip greens—broccoli, spoon cabbage (also known as white mustard cabbage or pakchoy), okra, rutabaga, and legumes (particularly soybeans). However, the quantity of these foods that would have to be consumed to obtain a significant amount of calcium would be beyond the capacity or preference of most individuals.

Most dried fruits and certain nuts (especially almonds) provide significant amounts of calcium. However, the proportion of calcium contributed to daily needs is modest compared with the proportion of food energy provided by these sources.

Meats are relatively poor sources of calcium. Canned fish, such as salmon or sardines, in which the bones are processed along with the meat are good sources, if the bones are consumed.

Grains provide only small amounts of calcium. However, grains may assume importance in meeting calcium needs when breads and cereals are regularly included in meals. The use of milk in bread and baked products improves their calcium content. Also, the use of lime-treated corn in the preparation of tortillas can add a significant amount of calcium to diets.

Obviously, to obtain recommended levels of calcium is difficult when milk and milk products are eliminated from the diet. With their exclusion, other foods—particularly fruits, vegetables, breads, and cereals—must be consumed in amounts that are often impractical in order to meet calcium allowances.

Phosphorus

Phosphorus is more widely distributed in foods than is calcium. It is associated mainly with protein-rich foods. Meats (especially organs), fish, poultry, eggs, cheese, and milk are excellent sources of phosphorus. A diet that supplies adequate amounts of protein and calcium usually furnishes enough phosphorus.

Bread and cereal products are also reliable sources of phosphorus. Whole grains are better sources than refined products. Generally, vegetables and fruits are not good sources of phosphorus.

Per capita consumption of soft drinks has more than doubled since 1960. Cola is the dominant flavor among these beverages, representing approximately 60 percent of the market. An increased consumption of these drinks is associated with higher levels of dietary phosphorus and may contribute to excessive phosphorus intake, resulting in

a dietary imbalance of calcium and phosphorus, particularly when soft drinks replace milk in the diet.

Vitamin D

Because vitamin D plays such an essential role in the absorption and utilization of both calcium and phosphorus, it is important to know what are the reliable sources of this vitamin. Vitamin D occurs naturally in only a few foods at levels of dietary significance: Egg yolk, butter, liver, and fish—such as sardines, salmon, herring, and tuna. However, milk is often fortified with vitamin D. Other foods, such as margarine and breakfast cereals, may have vitamin D added to them. A precursor of vitamin D in the body is modified to vitamin D through the action of sunlight exposure on the skin.

If food sources of vitamin D are eliminated from the diet, use of a vitamin preparation or of fish liver oils may be advisable, particularly for infants, young children, pregnant and nursing women, and for persons who seldom get out of doors and into the sunlight. However, care must be taken in the use of vitamin preparations and fish liver oils, because excessive amounts of vitamin D can be toxic.

CALCIUM-TO-PHOSPHORUS RATIOS OF DIFFERENT FOOD INTAKES

The following menus show how foods can be combined to provide different calcium-to-phosphorus ratios. The calcium and phosphorus content of each food, as well as the day's total, is shown. Each of the day's menus provides approximately 2,000 calories for 25-to-50-year old females. For purposes of illustrating an unbalanced calcium-to-phosphorus ratio, the calcium content of Menu III is inadequate.

The calcium-to-phosphorus ratio of Menu I is 1:1, which is considered a balanced ratio based on recommended allowances for calcium and phosphorus. The ratios of Menus II and III are approximately 1:2 and 1:3, respectively. While these ratios are not balanced according to recommended allowances, they may be acceptable if sufficient amounts of vitamin D are available.

A more favorable ratio is achieved in Menu I by including more dairy products which are the better sources of calcium. In contrast, Menus II and III contain fewer worthwhile sources of calcium and more substantial amounts of phosphorus from larger servings of meat, poultry, eggs, dried peas, beans, and nuts.

CONCLUSION

Concern exists in today's diets that phosphorus levels may be too high compared with calcium levels, thus adversely affecting the body's use of calcium. Little infor-

mation is available on actual dietary calcium-to-phosphorus ratios, so the extent of the problem, if present, is unknown. However, it now appears that a dietary imbalance of calcium to phosphorus may not be as important if sufficient vitamin D is available. Because clouds, fog, dust, and smog, as well as heavier clothing worn during the colder months, can cut down on the amount of sunlight available to form vitamin D naturally in the skin, people living in urban, temperate climates and those who seldom get out of doors might be wise to rely on other sources of this vitamin.

Based on dietary surveys, concern has been expressed about the proportion of persons consuming less than recommended amounts of calcium. The significance of lower dietary levels is difficult to assess because of the body's ability to adapt to a range of calcium intakes. Nevertheless, certain individuals are likely to be at higher risk for inadequate calcium intakes. These include low-income persons, teenage girls, pregnant and lactating women, elderly men, lactose-intolerant individuals, and possibly individuals on weight-reduction diets or with other socially, culturally, or medically restricted food patterns.

An issue of increasing concern is the relationship of protein intake to calcium utilization. Most Americans consume levels of protein in excess of recommendations. Although there is little evidence to show that a protein intake which exceeds the recommended allowance is of any real nutritional benefit to the healthy individual, an intake that exceeds allowances is often beneficial in maintaining desirable levels of certain other nutrients in the diet. There is growing evidence that calcium excretion is increased when protein intake is high. While the practical significance of this observation must await further definition, nutritionists should be alert to dietary patterns substantially in excess of the recommended allowance for protein and, at the same time, marginal in calcium.

Little is known about the phosphorus intake of the population. However, liberal consumption of foods known to be reliable sources of phosphorus, such as meats and cola drinks, can be expected to be associated with high dietary levels of phosphorus and possibly, imbalances in dietary calcium-to-phosphorus ratios.

Although clear-cut answers are not yet available on the significance of dietary calcium-to-phosphorus ratios or on whether critical imbalances exist, educators can:

- Place teaching emphasis on target groups which may be likely to have low calcium intakes.
- Help people to develop skills to identify calcium and phosphorus sources in their diets and to estimate their dietary status for these two nutrients. Assist learners and clients to identify acceptable sources of calcium and vitamin D and ways to incorporate them into their dietary patterns. Nutrition labeling can be helpful in making food selections for calcium and possibly for phosphorus and vitamin D.

MENU I

	<i>Amount</i>	<i>Calcium, mg</i>	<i>Phosphorus, mg</i>
Breakfast			
Cantaloup	1/2 melon	38	44
Grits	1/2 cup	1	12
Blueberry muffin	1	34	53
With butter or margarine	1 teaspoon	1	1
Skim milk	1 cup	296	233
TOTAL		370	343
Luncheon			
Grilled cheese sandwich:			
Bread, white	2 slices	34	38
Cheese	1 ounce	198	219
Butter or margarine	1 tablespoon	3	2
Pear	1 medium	13	18
Chocolate milkshake	11 ounces	312	304
TOTAL		560	581
Dinner			
Flank steak	3 ounces	12	128
Corn-on-cob	1 ear	2	69
With butter or margarine	1 teaspoon	1	1
Collards	3/4 cup	268	74
Raisin pie	1/8 of pie	21	47
Skim milk	1 cup	296	233
TOTAL		600	552
Evening snack			
Peach	1 medium	9	19
DAY'S TOTAL		1,539	1,495

MENU II

	<i>Amount</i>	<i>Calcium, mg</i>	<i>Phosphorus, mg</i>
Breakfast			
Tomato juice	1/2 cup	8	22
Bran flakes	1 cup	19	125
With skim milk	1/2 cup	148	116
Whole wheat toast	1 slice	23	52
Apple butter	1 tablespoon	2	6
Coffee (without cream or sugar)	1 cup	4	7
TOTAL		204	328
Luncheon			
Split pea soup	1 cup	29	149
Sandwich:			
Dried chipped beef	2 ounces	12	230
Whole wheat bread	2 slices	46	104
Tomato slices	1/2 tomato	6	12
Lettuce	1 leaf	4	4
Coffee (without cream or sugar)	1 cup	4	7
TOTAL		101	506

Afternoon snack

Peanuts	1/4 cup	27	144
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Dinner

Ham, lean baked	5 ounces	19	436
Sweet potato	1	46	66
With margarine	1 tablespoon	3	2
Green beans	1/2 cup	27	22
With toasted almonds	1 tablespoon	19	40
Chocolate pudding	1 cup	265	247
Coffee (without cream or sugar)	1 cup	4	7
TOTAL		383	820

Evening snack

Ice cream, chocolate	1/2 cup	97	76
Sandwich cookie	1	2	24
DAY'S TOTAL		814	1,898

MENU III

	<i>Amount</i>	<i>Calcium, mg</i>	<i>Phosphorus, mg</i>
Breakfast			
Grapefruit	1/2	16	16
Poached egg	1 large	27	103
Canadian bacon	2 slices	6	92
Toast, white	1 slice	24	27
With jam	1 tablespoon	4	2
Coffee (without cream or sugar)	1 cup	4	7
TOTAL		81	247
Luncheon			
Cream of mushroom soup	1 cup	41	50
Saltine crackers	6	3	15
With peanut butter	2 tablespoons	18	122
Banana	1 medium	10	31
Brownie	1	9	27
Coffee (without cream or sugar)	1 cup	4	7
TOTAL		85	252
Afternoon snack			
Lemonade	1 cup	2	3
Dutch pretzel	2	8	42
Dinner			
Chicken, broiled	1/2 broiler	16	355
Green peas	1/2 cup	22	64
Carrots	1/2 cup	26	24
Roll	1	21	24
With butter or margarine	1 teaspoon	1	1
Coconut custard pie	1/8 of pie	107	132
Coffee (without cream or sugar)	1 cup	4	7
TOTAL		197	607
Evening snack			
Plums	3	24	36
DAY'S TOTAL		397	1,187

REFERENCES

- Anonymous. Should milk drinking by children be discouraged? *Nutr. Reviews* 32: 366. 1974.
- Bogert, L. J., Briggs, G. M., and Calloway, D. H. *Nutrition and Physical Fitness*. Ninth ed. W. B. Saunders Co., Philadelphia, Pa. 1973.
- Food and Nutrition Board. *Recommended Dietary Allowances*, 1968. Seventh ed. National Academy of Sciences-National Research Council. 1968.
- Food and Nutrition Board. *Recommended Dietary Allowances*, 1974. Eighth ed. National Academy of Sciences-National Research Council. 1974.
- Garn, S. M. *The Earlier Gain and the Later Loss of Cortical Bone*. Charles C. Thomas, Springfield, Ill. 1970.
- Goodhart, R. S., and Shils, M. E. *Modern Nutrition in Health and Disease*. Lea & Febiger, Philadelphia, Pa. 1973.
- Guthrie, H. A. *Introductory Nutrition*. C. V. Mosby Co., St. Louis, Mo. 1967.
- Krook, L., Lutwak, L., Whalen, J. P., Henrikson, P., Lesser, G. V., and Uris, R. Human periodontal disease: Morphology and response to calcium therapy. *Cornell Vet.* 62: 32. 1972.
- Manalo, R., and Jones, J. E. The content of constant diets: A comparison between analyzed and calculated values. *Amer. J. Clin. Nutr.* 18: 339. 1966.
- Marshall, M. W., Iacono, J. M., Young, C. W., Washington, V. A., Slover, H. T., and Leapley, P. M. Composition of diets containing 25 and 35 percent calories from fat. *J. Amer. Dietet. Assoc.* 66: 470. 1975.
- Martin, E. A. *Nutrition in Action*. Third ed. Holt, Rinehart and Winston, Inc., New York, N.Y. 1971.
- Murphy, E. W., Page, L., and Watt, B. K. Major mineral elements in type A school lunches. *J. Amer. Dietet. Assoc.* 57: 239. 1970.
- Nutrition Reviews' Present Knowledge in Nutrition*. Fourth ed. Nutrition Foundation, Inc. 1976.
- Stare, F. J., and McWilliams, M. *Living Nutrition*. John Wiley & Sons, Inc., New York, N.Y. 1973.
- Tipton, I. H., and Stewart, P. L. Long term studies of elemental intake and excretion of three adult male subjects. *Developments in Appl. Spectroscopy* 8: 40. 1970.
- U.S. Department of Agriculture, Agricultural Research Service. Food and nutrient intake of individuals in the United States, spring 1965. U.S. Dept. Agr. Household Food Consumption Survey 1965-66. Report No. 11. 1972.
- U.S. Department of Agriculture, Agricultural Research Service. Food for fitness—a daily food guide. U.S. Dept. Agr. Leaflet 424. Sl. rev. 1973.
- U.S. Department of Agriculture, Economic Research Service. Sugar and Sweetener Report. V. 1, No. 8. 1976.
- U.S. Department of Health, Education, and Welfare, Health Service and Mental Health Administration. Ten-state nutrition survey, 1968-70. V. Dietary. Pub. No. (HSM) 72-8133. 1972.
- U.S. Department of Health, Education, and Welfare, Public Health Service, Health Resources Administration. Preliminary findings of the first health and nutrition examination survey, United States, 1971-72: Dietary intake and biochemical findings. Pub. No. (HRA) 74-1291-1. 1974.
- Walker, M. A., and Page, L. Nutrient content of college meals. III. Minerals. (In press.)
- White, H. S. Inorganic elements in weighed diets of girls and young women. *J. Amer. Dietet. Assoc.* 55:38. 1969.
- White, P. L., and Selvey, N. *Let's talk about foods*. Publishing Sciences Group, Inc., Acton, Mass. 1974.
- Wilson, E. D., Fisher, K. H., and Fuqua, M. E. *Principles of Nutrition*. Third ed. John Wiley & Sons, Inc., New York, N.Y. 1975.

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